Relationship between trophic component of different poplar strains and occurrence of *Saperda poplnea*

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Abstract: An experimental area of poplar was established in Songyuan of Jilin Province in 1999 for testing the resistance of different poplar stains to *Saperda poplnea*. Incidence of *S. poplnea* on ten poplar strains were investigated, and the main trophic component of branches of these poplar trees were measured and analyzed in April 2001. The results showed that there existed significant difference in population size of *S. poplnea* on different poplar strains, and the branches of these poplar strains have significant difference in nutrient component and content of amino acids. The population size of this pest had a significantly positive correlation with dissolvable total sugar and water content but had no significant correlation with content of total nitrogen and protein nitrogen.

Keywords: *Saperda poplnea*, Poplar strains, Pest resistance
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Introduction

Saperda poplnea, belonging to *Saperda*, Cerambyadae, Coleoptera, is a dangerous pest species and mainly damages branches and stems, especially shoots, of *Saliaceae* as larvae. The larvae firstly bore and feed between phloem and xylem, gradually entering xylem, and hinder the transport of nutriment. And a spindle gall tumor that formed on injured spot leads to withering or windthrowing of branches. *S. poplnea* distributes widely in Germany, Russia, Korea, North Africa, and China. Its distribution areas in China include Heilongjiang, Jilin, Liaoning, Inner Mongolia, Hebei, Henan, Beijing, Shanxi, Shanxi, Qinghai, Ningxia, Xingjiang, ect. Since this pest attacks almost all strains of *Populus* and seriously occurred in "Three North" area, especially in Jilin and Heilongjiang in recent years, it has attracted significant attention from local government and administrative sectors of forestry. So far, by a quantity of investigations, no absolutely resistant *Populus* strains to *S. poplnea* has been found, but it has been found that there exists significant difference between different strains for resistance to this pest. Research on relationship between trophic component of different *Populus* strains and *S. poplnea* is of much importance for searching resistance mechanism and for establishing a scientifically based precaution and control strategy. This paper analyzed main trophic components of different poplar strains and their relationships with population density of *S. poplnea*

Material and method

Ten poplar varieties were planted in western forest area of Wulantuga Forest Farm, Songyuan in spring 1999. The intercrop was implemented by six rows of corn with one row of trees in 1999 and by sarphum and trees in 2000. In 2001 spring, before sap flows, two branches of 0.5 m in length were taken from every strain tree, kept wet, and tested within two days.

Drying methods, Kjeldahl method, and Anthrone method were adopted respectively for determining water content, total nitrogen and protein nitrogen, and dissolvable total sugar of poplar branches. Amino acids were analyzed in the Analysis Center of Jilin Agriculture University. Samples were taken on April 9th 2001n and tested according to GB7649-87. Automatic analyzer of amino acid was used in analysis and the test was carried out at temperature of 18 °C and humidity of 44%.

To avoid including the insect galls of *Paranthrene tabaniformis,* all galls on whole tree were broken to investigate the population of the alive *S. poplnea* per tree in August 2000 and April 2001. Survey site is eastern to western forest area of Wulantuga Forest Farm, Songyuan.

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Result and analysis

Comparison of population densities of *S. poplnea* on different strains of poplar

The population density of *S. poplnea* on ten poplar strains were investigated and nutrient components of these poplar strains were measured (see Table 1 and Fig 1). Variance analysis showed that there exists significant difference in attacking degree by *S. poplnea* between these poplar strains (see Table 2).

Table 1. Population density of S. *poplnea* on different poplar strains and analysis of their nutrient components of poplar braches

Poplar varieties	Population density (Heads/ tree)	Moisture content (%)	Total nitrogen (%)	Protein nitrogen (%)	Dissolvable total sugar (μ g/g)
Bailin 3	0.78	24.87	0.7230	0.6263	127.53
Poplar 3920	1.71	31.85	0.6827	0.555	292.67
Baicheng 2	1.93	34.09	0.4829	0.4649	317.31
Fa 9	2.11	34.49	0.578	0.5569	284.49
Sikelin	2.33	32.48	0.6861	0.6159	316.73
Xi 3.5	3.38	51.08	0.5741	0.5368	330.63
Gelude	3.56	41.62	0.6587	0.6303	309.95
XI 4	4.29	40.19	0.6524	0.6163	413.19
XI 2	4.33	34.99	0.6689	0.5775	393.81
Poplar 8203	4.33	40.53	0.5513	0.4634	280.29

Table 2. Variance analysis of *S. poplnea* occurrence of ten strains of poplar

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	128.7455	9	14.30506	2.890178	0.004942	1.990617
Within Groups	425.6607	86	4.949543			
Total	554.4063	95				

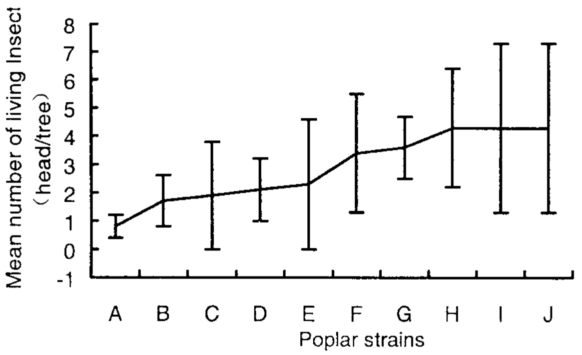

Fig. 1 Curve of *S. poplnea* occurrence of 10 strains of poplar
A—Bailin No.3, B—Poplar 3920, C—Baicheng No.2, D--FA9, E—Sikelin, F—XI3.5, G—Gelude, H—XI 4, I—XI 2, J—Poplar 8203

Relationship between nutrient component of poplar branches and population of *S. poplnea*

Table 3 presents result of correlation analysis for *S. poplnea* population and main trophic component of corresponding comminuted sample branches. The correlation coefficient is 0.737 with dissolvable total sugar and 0.684 with water content. And there's no significant correlation with total nitrogen and protein nitrogen.

Table 3. Correlation analysis for Nutrient Component sof poplar branches and population of *S. poplnea*

Nutrient Component	Correlation coefficient
Moisture content (%)	0.684
Total nitrogen 氮 (%)	-0.166
Protein nitrogen (%)	-0.100
dissolvable total sugar (μ g/g)	0.737

Comparison for the contents of varied amino acids of different *Populus* strains and their relationship with *S. poplnea* population.

Using samples of comminuted branches, amino acid content of every strain was analyzed for determining the relationship between nitrogen element in *Populus* branches and *S. poplnea* population (see Table 4). Statistical analysis for amino acid content presented as in Fig. 2 showed that there's significant difference in amino acid content between these poplar strains (see Table 5), but no significant correlation exists between total content of amino acid and *S. poplnea* population (see Table 6).

Discussion

During the long co-evolution course, *Saperda* and poplar trees are always in a dynamic balance of compelling selection, adaptation and inadaptation. And in the course, they must have formed a complex resistant relationship. Besides researches on main trophic component concerned in this paper, research on mechanism of poplar resistance to *S. poplnea* should include physical character of branches, e.g. depth of phelloderm and sclereid content, and research on secondary metabolite. The secondary material is usually regulating factors of insect. Volatile secondary material of plant, which are some organic chemical material with molecular weight of about 100 to 200, are usually generated by biosynthesis pathway, e.g. alcohol and ethyl acetate by glycolysis. Chloranthy alcohol and aldehyole and their derivation are generated from unsaturated fatty acid. Ter-

pene and their derivation, with high content in conifer trees, can all influence the behavior of *S. poplnea*.

Table 4. Amino acid contents of branches of 10 poplar strains **(Unit: %)**

Strains of poplar	Asp	Thr	Ser	Glu	Gly	Ala	Val	Met	Ile	Leu	Tyr	Phe	Lys	His	Arg	Pro
Bailin 3	0.486	0.213	0.256	0.538	0.256	0.277	0.325	0.215	0.243	0.299	0.091	0.232	0.306	0.007	0.040	0.187
Poplar 3920	0.348	0.125	0.168	0.374	0.155	0.215	0.186	0.055	0.116	0.201	0.112	0.169	0.205	0.035	0.062	0.160
Baicheng 2	0.232	0.083	0.138	0.208	0.117	0.130	0.135	0.044	0.082	0.118	0.057	0.080	0.130	0.026	0.022	0.100
Fa 9	0.337	0.106	0.136	0.331	0.147	0.156	0.213	0.079	0.116	0.161	0.046	0.088	0.157	0.047	0.028	0.128
Sikelin	0.342	0.130	0.163	0.352	0.195	0.195	0.234	0.083	0.147	0.224	0.077	0.112	0.171	0.069	0.032	0.230
Xi 3.5	0.403	0.141	0.168	0.390	0.168	0.197	0.241	0.101	0.129	0.206	0.093	0.133	0.239	0.043	0.044	0.136
Gelude	0.410	0.161	0.204	0.447	0.221	0.254	0.288	0.077	0.196	0.312	0.149	0.286	0.297	0.092	0.056	0.209
XI 4	0.368	0.148	0.174	0.402	0.170	0.203	0.199	0.084	0.142	0.199	0.098	0.155	0.206	0.049	0.039	0.172
XI 2	0.386	0.138	0.169	0.401	0.188	0.231	0.227	0.084	0.135	0.236	0.141	0.166	0.237	0.068	0.042	0.194
Poplar 8203	0.251	0.089	0.122	0.263	0.122	0.144	0.164	0.044	0.103	0.150	0.061	0.105	0.168	0.040	0.031	0.108

Table 5. Varriance analysis of amino acid content of ten poplar strains

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.271955	9	0.030217	3.200648	0.001425	1.942794
Within Groups	1.416144	150	0.009441			
Total	1.688098	159				

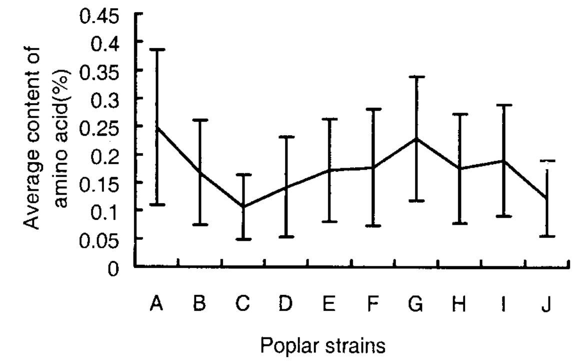

Fig 2. Comparison of amino acid content of 10 poplar stains
A—Bailin NO.3, B—Poplar 3920, C—Baicheng No.2 D--FA9, E—Sikelin, F—XI3.5, G—Gelude, H—XI 4, I—XI 2, J—Poplar 8203

Table 6. Correlation between every kind of amino acid of poplar branches and incidence of *S. poplnea*

Amino acid	Correlation coefficient with incidence of *S. poplnea*	Amino acid	Correlation coefficient with incidence of *S. poplnea*
Asp	-0.183	Ile	-0.269
Thr	-0.237	Leu	-0.081
Ser	-0.371	Tyr	0.329
Glu	-0.159	Phe	-0.014
Gly	-0.242	Lys	-0.017
Ala	-0.136	His	0.576
Val	-0.229	Arg	0.044
Met	-0.454	Pro	-0.002

As shown in Table 3, the incidence of *S. poplnea* has positive correlation with dissolvable carbohydrate and water content, but no correlation with nitrogen content of poplar strains. Similar as that to *Anoplophora nobilis* Ganglbauer and *Anoplophora glabripennis* (Motschulsky), the water content of branches is an important factor which restrains egg-laying, hatching, and larvae growth of *S. poplnea*. It may be said that the correlation between incidence of *S. poplnea* and dissolvable sugar of poplar is related to their food philia and digestive and absorptive mechanism. The fact that incidence of *S. poplnea* has no correlation with nitrogen content of poplar strains is possibly because they have shelter protection and sufficient food in branch during 80 percent of their life cycle, and they don't need high quality food of nitrogen to keep alive.

The conclusion above needs further research and discussion and further elaboration should be given on physiological metabolism machines of *S. poplnea*.

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